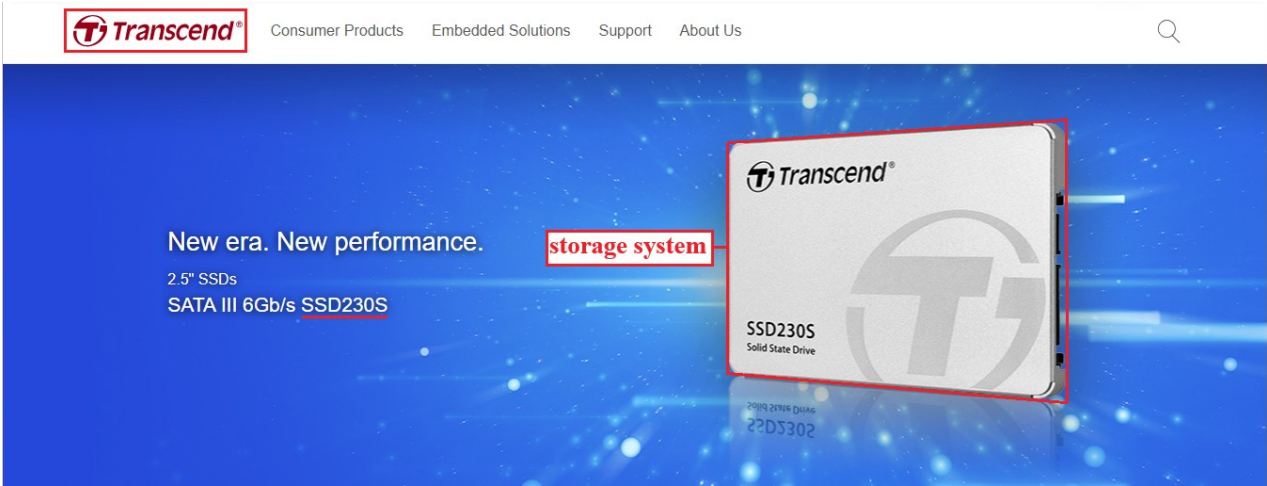
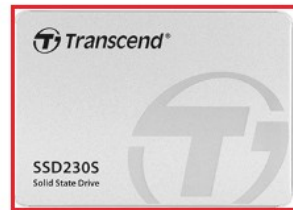


Exhibit 2

Method Claim: 1

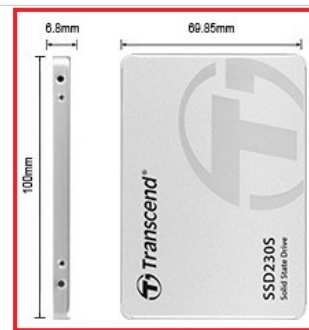
US10095426	Transcend SSD230S ("The accused product")
<p>1. A method of storing data on a storage system comprising:</p>	<p>The accused product discloses a method of storing data on a storage system (e.g., the accused product).</p> <p>As shown below, the accused product is a storage system used by a host, such as a computer, to store data. SSDs use a controller to write data from the host to NAND flash in the form of blocks, managing wear leveling, error correction, and data integrity to optimize performance and extend the drive's lifespan.</p>  <p>https://us.transcend-info.com/product/internal-ssd/ssd230s</p>

SATA III 6Gb/s SSD230S



Transcend's SATA III 6Gb/s SSD230S uses the latest 3D NAND technology that features vertical, stacked expansion of storage cells. By using high-quality flash memory and enhanced firmware algorithms, the SSD230S delivers greater performance and reliability.

<https://us.transcend-info.com/product/internal-ssd/ssd230s>



storage system

Appearance

Dimensions	100 mm x 69.85 mm x 6.8 mm (3.94" x 2.75" x 0.28")
Weight	53 g (1.87 oz)

Storage

Flash Type	3D NAND flash
Capacity	128 GB / 256 GB / 512 GB / 1 TB / 2 TB / 4 TB

<https://us.transcend-info.com/product/internal-ssd/ssd230s>

Introducing the NAND Flash SSD

Like an HDD, an SSD is a nonvolatile storage device that store data whether or not it is connected to power. An HDD, however, uses magnetic media to store its data, whereas the SSD uses integrated electronic circuitry to retain specific charge states, which in turn map to the data bit patterns.

SSDs are based on flash memory technologies that enable data to be written, read, and erased multiple times. Flash memory comes in two varieties: NOR and NAND. Although each offers advantages and disadvantages (a discussion beyond the scope of this article), NAND has emerged as the favored technology because it delivers faster erase and write times. Most contemporary SSDs are based on NAND flash, which is why it's the focus of this article.

An enterprise SSD contains multiple NAND flash chips for storing data. Each chip contains one or more dies, and each die contains one or more planes. A plane is divided into blocks, and a block is divided into pages.

<https://www.red-gate.com/simple-talk/databases/sql-server/database-administration-sql-server/storage-101-understanding-the-nand-flash-solid-state-drive/>

Writing data is a programming operation that sets the data bits to the desired charge state, a process orchestrated by the controller. – Writing data to a page for the first time is nearly as straightforward as reading data. The process grows more complex when modifying that data, which requires that it first be erased and then rewritten, a process commonly referred to as a program/erase cycle (P/E cycle).

During a typical P/E cycle, the entire block containing the targeted pages is written to memory. The block is then marked for deletion and the updated data rewritten to another block. The actual erase operation occurs asynchronously in order to optimize performance.

<https://www.red-gate.com/simple-talk/databases/sql-server/database-administration-sql-server/storage-101-understanding-the-nand-flash-solid-state-drive/>

As P/E cycles start adding up, cells start failing. For this reason, SSDs employ several strategies to extend a drive's lifespan, assure reliability, and maintain data integrity, including:

- **Wear leveling:** A controller-based operation for distributing P/E cycles evenly across the NAND chips to prevent any cells from premature failure.
- **TRIM command:** An operating system command for consolidating a drive's free space and erasing blocks marked for deletion, which can improve performance and minimize write application.
- **Over-provisioning:** Extra drive space reserved for management processes such as wear leveling and for reducing the extra write amplification that occurs when a drive gets too full.
- **Caching:** A process of storing data in memory to boost performance and, when used effectively, minimize P/E cycles.
- **Error-correction code (ECC):** A process for checking data for errors and then, if necessary, correcting those errors.

An SSD might also incorporate strategies for improving performance. For example, flash drives implement garbage collection, a background process for moving, consolidating, and erasing data. There's some debate about whether garbage collection adds write amplification or reduces it. It depends on how the garbage collection operations are implemented and the quality of the algorithms used to carry out these operations.

<https://www.red-gate.com/simple-talk/databases/sql-server/database-administration-sql-server/storage-101-understanding-the-nand-flash-solid-state-drive/>

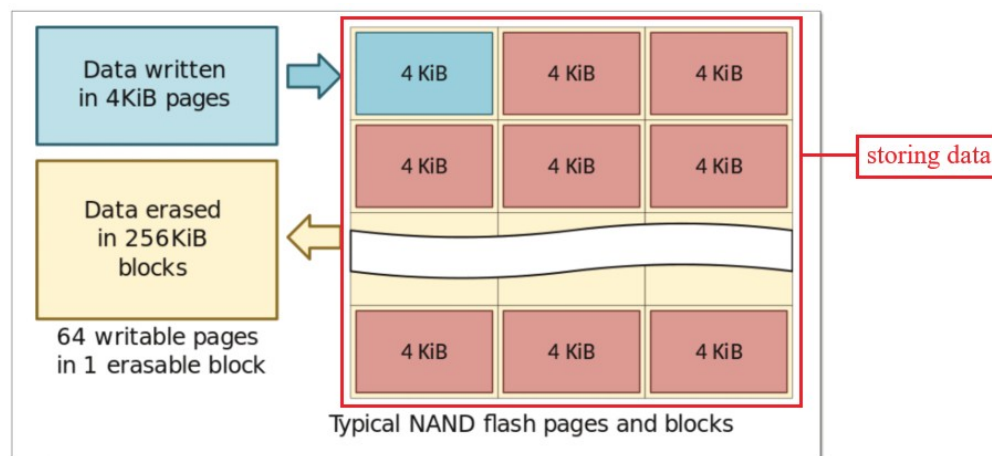
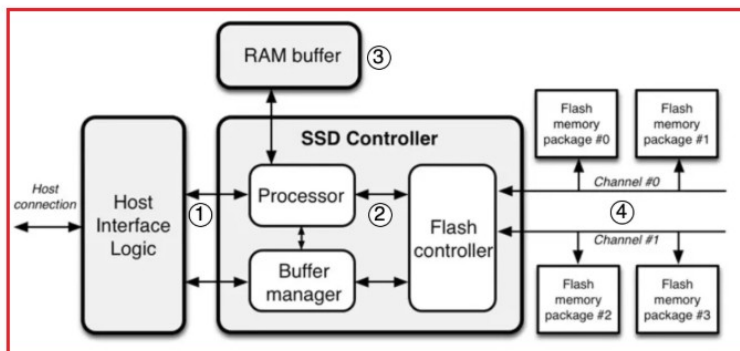


Figure 1. Writing and erasing data in a NAND flash SSD (image by Dmitry Nosachev, licensed under Creative Commons Attribution-Share Alike 4.0 International)

<https://www.red-gate.com/simple-talk/databases/sql-server/database-administration-sql-server/storage-101-understanding-the-nand-flash-solid-state-drive/>

[state-drive/](#)

SSD Architecture



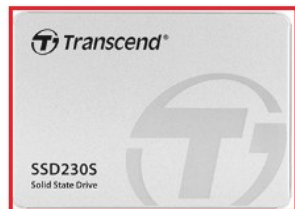
<https://blog.bytebytego.com/p/why-is-a-solid-state-drive-ssd-fast>

providing a storage medium as part of the storage system;

The accused product discloses, providing a storage medium (e.g., NAND flash) as part of the storage system (e.g., the accused product).

As shown below, the accused product is a storage system which uses 3D TLC NAND flash as the storage medium.

SATA III 6Gb/s SSD230S



Transcend's SATA III 6Gb/s SSD230S uses the latest 3D NAND technology that features vertical, stacked expansion of storage cells. By using high-quality flash memory and enhanced firmware algorithms, the SSD230S delivers greater performance and reliability.

<https://us.transcend-info.com/product/internal-ssd/ssd230s>

Transcend targets the mass market with their SSD230S SSD. This is their first SSD to utilize the 3D NAND technology. While 3D NAND does bring better performance and an increase in storage density, it does have a lower endurance level. Therefore, there is a need to adopt special techniques and technologies to improve the durability of the product.

<https://thetechrevolutionist.com/2018/06/transcend-ssd230s-review-affordable-performance-oriented-ssd.html>



storage system

Appearance

Dimensions	100 mm x 69.85 mm x 6.8 mm (3.94" x 2.75" x 0.28")
Weight	53 g (1.87 oz)

Storage

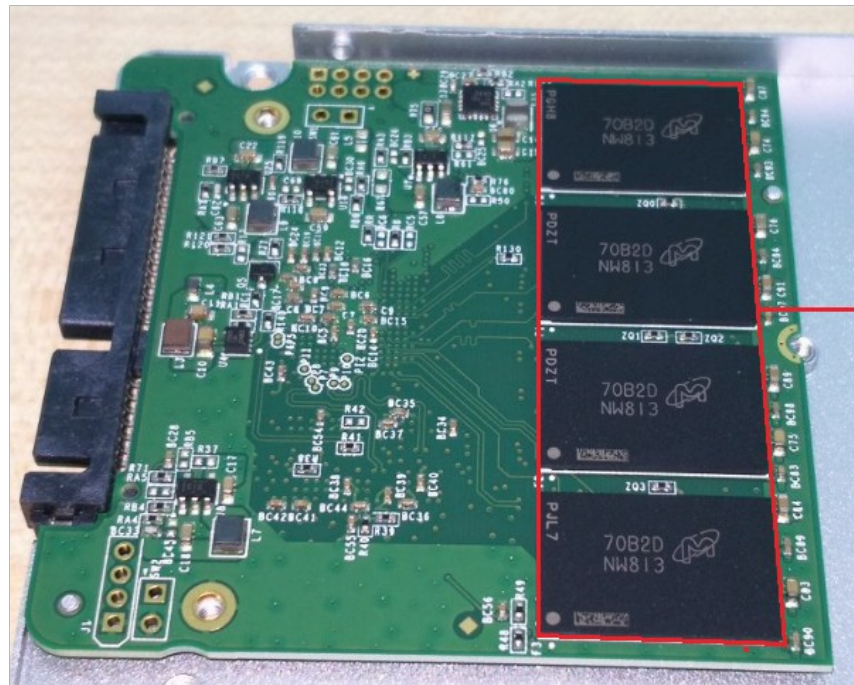
Flash Type	3D NAND flash	storage medium
Capacity	128 GB / 256 GB / 512 GB / 1 TB / 2 TB / 4 TB	

<https://us.transcend-info.com/product/internal-ssd/ssd230s>

Specification

Model	Transcend SSD230S — storage system
Interface	SATA/AHCI
Form factor	2.5"
Capacity	128GB-2TB
Controller	SMI SM2258
Configuration	Single-core, 4-ch, 8-CE/ch
DRAM	Yes
HMB	N/A
NAND brand	Micron
NAND type	TLC — storage medium
Layer	32/64

<https://www.hardware-corner.net/ssd-database/Transcend-SSD230S/>



storage medium

There are 4 3D TLC NAND flash memory chip from Micron that's spotted on the SSD.
This also means that each NAND memory chip holds up 32GB (or possibly more) of storage space. The sample that we had is a 128GB model.

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NAND type

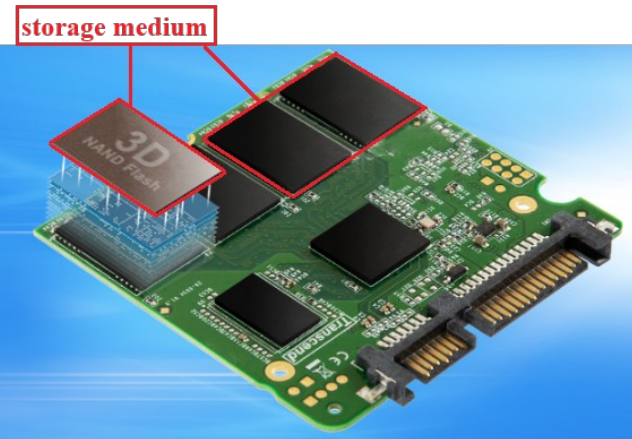
Transcend SSD230S is using a TLC (3 bits per cell) NAND manufactured by Micron with 32/64 cell layers on top of each other.

The TLC is the most common type of SSD NAND flash memory found on the market at the moment. It is faster, less durable, but still cheaper than the other, more expensive variants - SLC and MLC.

<https://www.hardware-corner.net/ssd-database/Transcend-SSD230S/>

3D expansion to break through limits

Unlike planar NAND memory, 3D NAND flash features memory cells stacked vertically in multiple layers. 3D NAND overcomes density limitations of 2D planar NAND, and delivers a higher level of performance and endurance.



<https://us.transcend-info.com/product/internal-ssd/ssd230s>



storage system

Transcend SSD230S

SSD Specification and Info

Transcend SSD230S is an Mid-Range SATA SSD produced and sold by Transcend. The device comes with SATA/AHCI interface and 2.5" form factor - a good fit for both desktop and laptop computers. This SSD has a maximum sequential read-write speed of up to 560/520 MB per second, making it ideal for gaming and workstation PCs.

Transcend SSD230S is equipped with DRAM memory, and a TLC NAND flash memory with 32/64 cell layers.

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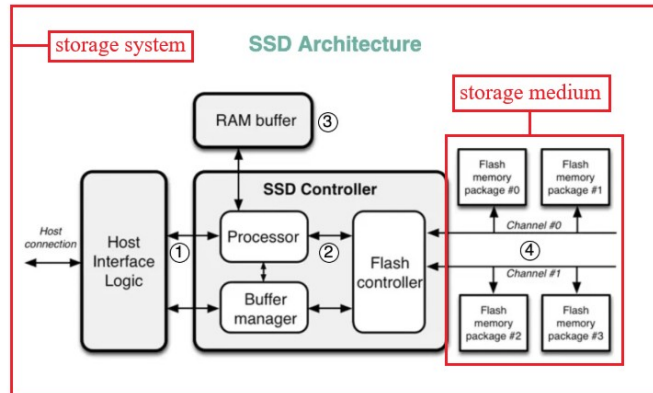
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An enterprise SSD contains multiple NAND flash chips for storing data. Each chip contains one or more dies, and each die contains one or more planes. A plane is divided into blocks, and a block is divided into pages.

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<https://blog.bytebytego.com/p/why-is-a-solid-state-drive-ssd-fast>

storing general purpose data on the storage medium using a first physical storage format attribute; and

The accused product discloses storing general purpose data (e.g., slower sustained data) on the storage medium (e.g., NAND flash) using a first physical storage format attribute (e.g., memory blocks configured as TLC).

As shown below, the accused product is a storage system that uses 3D TLC NAND as its storage medium. Data from the host is written to the storage medium via a controller. The accused product features an 'SLC Mode', which temporarily allocates TLC blocks as an SLC buffer to enhance performance. For time-critical and high-speed tasks, the controller utilizes the SLC buffer, while TLC blocks are used for operations that do not require the high speeds of the SLC buffer but instead demand stable, sustained speeds with minimal fluctuations, such as background data storage and surveillance data recording.

Specification

Model	Transcend SSD230S	storage system
Interface	SATA/AHCI	
Form factor	2.5"	
Capacity	128GB-2TB	
Controller	SMI SM2258	
Configuration	Single-core, 4-ch, 8-CE/ch	
DRAM	Yes	
HMB	N/A	
NAND brand	Micron	
NAND type	TLC	storage medium
Layer	32/64	

<https://www.hardware-corner.net/ssd-database/Transcend-SSD230S/>

NAND type

Transcend SSD230S is using a TLC (3 bits per cell) NAND manufactured by Micron with 32/64 cell layers on top of each other.

The TLC is the most common type of SSD NAND flash memory found on the market at the moment. It is faster, less durable, but still cheaper than the other, more expensive variants - SLC and MLC.

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The Transcend 2TB SSD230S SSD is designed with the latest 3D NAND technology. Featuring premium-quality flash memory and enhanced firmware algorithms, the SSD230S offers you guaranteed reliability and superior performance. Engineered with built-in SLC caching technology and a SATA III 6GB/second interface, the Transcend SSD230S provides blazing fast transfer speeds of up to 560MB/s read and 520MB/s write. Also works great with high-end gaming systems.

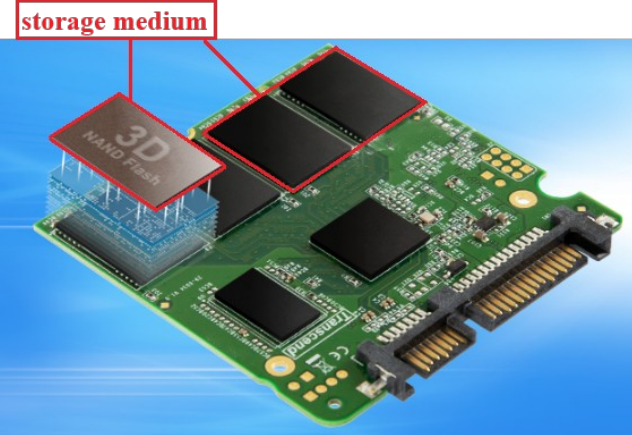
Features

- 2TB
- Latest 3D NAND flash
- Ensured data integrity with RAID engine and LDPC (Low-Density Parity Check) coding
- Exceptionally fast transfer speeds thanks to built-in SLC caching technology
- Supports S.M.A.R.T., TRIM, DevSleep ultra low power state, and NCQ commands

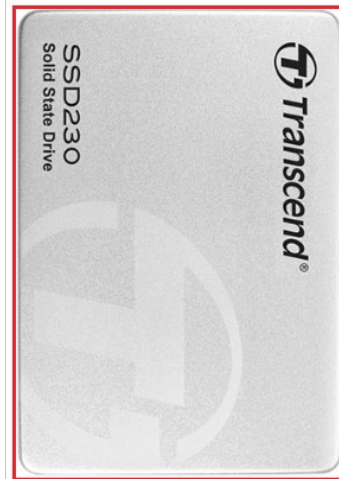
<https://www.oempcworld.com/OEMPCworld-com/501527.html>

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Unlike planar NAND memory, 3D NAND flash features memory cells stacked vertically in multiple layers. 3D NAND overcomes density limitations of 2D planar NAND, and delivers a higher level of performance and endurance.



<https://us.transcend-info.com/product/internal-ssd/ssd230s>



Transcend SSD230S

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Transcend SSD230S is equipped with DRAM memory, and a TLC NAND flash memory with 32/64 cell layers.

<https://www.hardware-corner.net/ssd-database/Transcend-SSD230S/>

TLC Direct Write

TLC direct write is a method of writing data on SSDs that differs from traditional methods. In traditional methods, data is first written to an SLC Cache to achieve high performance. However, when the SLC Cache is full, performance may drastically drop. TLC direct write eliminates the need for an SLC Cache and directly writes data to the TLC (Triple-Level Cell) NAND. This approach ensures a stable and consistent level of write performance. TLC direct write is widely used in applications that require fast and stable write speeds, such as data collection and high-speed photography. It allows for sustained write performance without performance degradation, meeting the demands of data-intensive tasks like surveillance data recording.

<https://www.yansen-ssd.com/technology/tlc-direct-write>

Comparison	SLC Cache	Direct TLC Write
Peak Performance	Higher	Lower
Performance Stability	Unstable write	Stable write
Suitable Applications	Small, less strenuous transactions <ul style="list-style-type: none"> • Online transactions • Cloud computing • Online gaming • Infotainment • Enterprise storage • Communications • Transportation system/control • Data recorders 	<ul style="list-style-type: none"> • Boot-up device • Surveillance/monitoring

Table 2. Comparison of SLC cache and direct TLC write

using a first physical storage format attribute

<https://www.atpinc.com/blog/what-is-SLC-cache-difference-between-Dynamic-Static-SLC-cache>

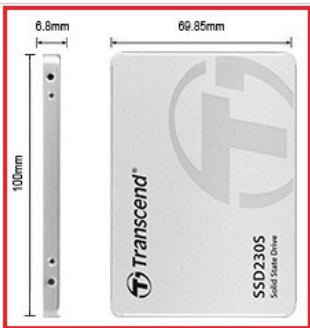
SLC caching is a sophisticated technique used for write caching on SSDs. It enables high transfer speeds for writes, even reaching hundreds of gigabytes on flash memory that typically cannot sustain such speeds. Data written to the cache is swiftly transferred to the TLC or QLC flash memory to ensure the cache is available for peak transfer speeds.

<https://www.advantech.com/en-us/resources/news/maximizing-ssd-performance-with-slc-cache>

storing streaming data on the storage medium using a second physical storage format attribute different than said first physical storage format attribute;

The accused product discloses storing streaming data (high speed low latency data) on the storage medium (e.g., NAND flash) using a second physical storage format attribute (e.g., memory blocks configured as single-bit per cell, SLC) different than said first physical storage format attribute (e.g., memory blocks configured as TLC).

As shown below, the accused product is a storage system that uses 3D TLC NAND as its storage medium. Data from the host is written to the storage medium via a controller. The accused product features an 'SLC Mode', which temporarily allocates TLC blocks as an SLC buffer to enhance performance. For time-critical and high-speed tasks, the controller utilizes the SLC buffer, while TLC blocks are used for operations that do not require the high speeds of the SLC buffer but instead demand stable, sustained speeds with minimal fluctuations, such as background data storage and surveillance data recording.



storage system

Appearance	
Dimensions	100 mm x 69.85 mm x 6.8 mm (3.94" x 2.75" x 0.28")
Weight	53 g (1.87 oz)
Storage	
Flash Type	3D NAND flash
Capacity	128 GB / 256 GB / 512 GB / 1 TB / 2 TB / 4 TB

<https://us.transcend-info.com/product/internal-ssd/ssd230s>

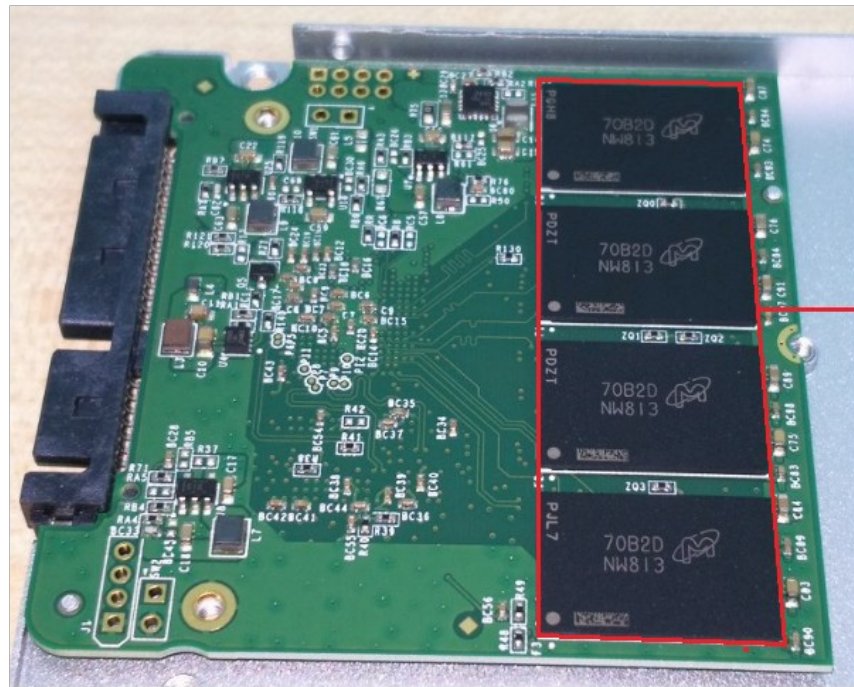


The Transcend 2TB SSD230S SSD is designed with the latest 3D NAND technology. Featuring premium-quality flash memory and enhanced firmware algorithms, the SSD230S offers you guaranteed reliability and superior performance. Engineered with built-in SLC caching technology and a SATA III 6GB/second interface, the Transcend SSD230S provides blazing fast transfer speeds of up to 560MB/s read and 520MB/s write. Also works great with high-end gaming systems.

Features

- 2TB
- Latest 3D NAND flash
- Ensured data integrity with RAID engine and LDPC (Low-Density Parity Check) coding
- Exceptionally fast transfer speeds thanks to built-in SLC caching technology
- Supports S.M.A.R.T., TRIM, DevSleep ultra low power state, and NCQ commands

<https://www.oempcworld.com/OEMPCworld-com/501527.html>



storage medium

There are 4 3D TLC NAND flash memory chip from Micron that's spotted on the SSD.
This also means that each NAND memory chip holds up 32GB (or possibly more) of storage space. The sample that we had is a 128GB model.

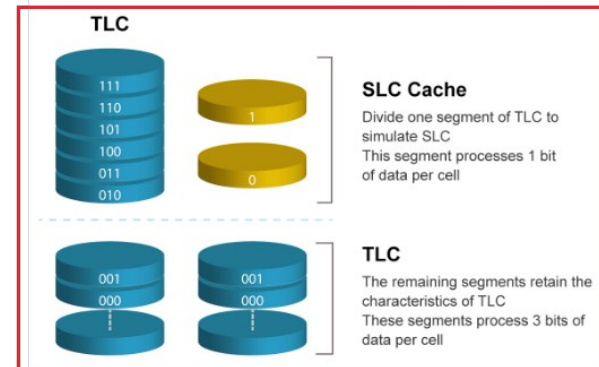
<https://thetechrevolutionist.com/2018/06/transcend-ssd230s-review-affordable-performance-oriented-ssd.html>

SLC Mode

SLC Cache limitations mean this technology cannot fulfill the demand for constant read/write at high speeds. That being so, another technology that can transform TLC into SLC has come into play—SLC Mode. Unlike SLC Cache, there are no buffer zone restraints on SLC Mode, because each TLC cell acting under this mode processes only one bit of data—just like SLC cells. Hence space constraints are removed and high read/write speeds can be sustained.



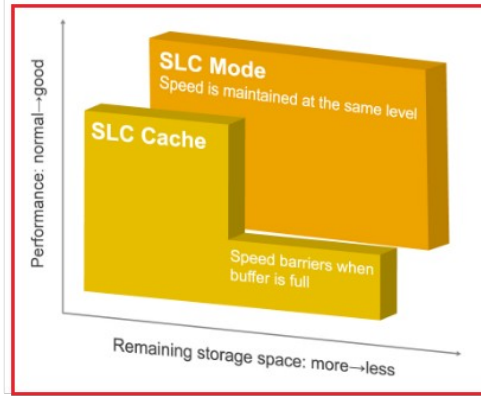
<https://www.transcend-info.com/embedded/technology/slc-mode>



SLC Cache

By dividing a segment within TLC to simulate SLC, transfer speeds within the segment will be temporarily increased. Once buffer space is full, speed will return to its original level.

<https://www.transcend-info.com/embedded/technology/slc-mode>



Although storage capacity per cell is reduced in SLC mode, taking three times amount of cells in TLC to simulate SLC, the cost is dozens of times less than SLC. This makes SLC mode an enticing alternative for companies seeking high storage capacity, high speed, and low cost.

<https://www.transcend-info.com/embedded/technology/slc-mode>

As P/E cycles start adding up, cells start failing. For this reason, SSDs employ several strategies to extend a drive's lifespan, assure reliability, and maintain data integrity, including:

- **Wear leveling:** A controller-based operation for distributing P/E cycles evenly across the NAND chips to prevent any cells from premature failure.
- **TRIM command:** An operating system command for consolidating a drive's free space and erasing blocks marked for deletion, which can improve performance and minimize write application.
- **Over-provisioning:** Extra drive space reserved for management processes such as wear leveling and for reducing the extra write amplification that occurs when a drive gets too full.
- **Caching:** A process of storing data in memory to boost performance and, when used effectively, minimize P/E cycles.
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<https://www.red-gate.com/simple-talk/databases/sql-server/database-administration-sql-server/storage-101-understanding-the-nand-flash-solid-state-drive/>

Comparison	SLC Cache	Direct TLC Write
Peak Performance	Higher	Lower
Performance Stability	Unstable write	Stable write
using a second physical storage format attribute	Small, less strenuous transactions	
Suitable Applications	<ul style="list-style-type: none"> • Online transactions • Cloud computing • Online gaming • Infotainment • Enterprise storage • Communications • Transportation system/control • Data recorders 	<ul style="list-style-type: none"> • Boot-up device • Surveillance/monitoring

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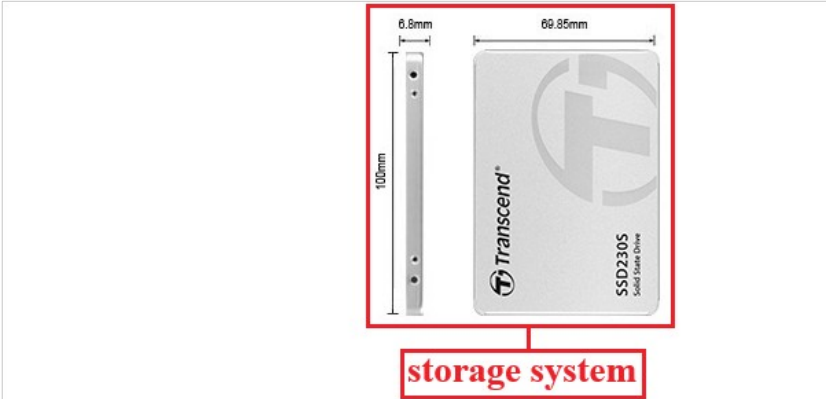
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<https://www.oempcworld.com/OEMPCworld-com/501527.html>

	<p><u>Whole-Drive Fill: Testing SLC Cache Size</u></p> <p>Most modern drives, in order to accelerate writing speed, designate a part of the drive as an 'SLC cache'. This is part of the storage that acts in 'single bit-per-cell' mode, which allows for faster reads and writes. The reason why it isn't used across the whole drive is that it doesn't allow as much data to be stored in the same area (TLC is three bits per cell, so 3x the density). As the user puts a sustained file write on the drive, this SLC cache will fill up at full speed. If the write size is bigger than the cache and goes without a break, it can spill into normal TLC territory (which is slower). When there is a pause in operation, the drive will compact the data in the SLC cache and move it to TLC blocks, freeing up cache space for future writes. Some drives adjust the size of this SLC cache dynamically based on the amount of free space left, while others have it as a fixed capacity.</p> <p>https://www.anandtech.com/show/13759/comparing-adata-sx8200-pro-vs-hp-ex950/2</p>
said first and second physical storage attributes being associated with differing storage qualities selected from the group consisting of: resilience to errors, data integrity, storage density, and storage capacity.	<p>The accused product discloses storing data using first and second physical storage attributes (e.g., memory blocks configured as SLC and TLC), said first and second physical storage attributes (e.g., memory blocks configured as SLC and TLC) being associated with differing storage qualities selected from the group consisting of: resilience to errors, data integrity, storage density, and storage capacity.</p> <p>As shown below, the accused product is a storage system that uses 3D TLC NAND as its storage medium. Data from the host is written to the storage medium via a controller. The accused product features an 'SLC Mode', which temporarily allocates TLC blocks as an SLC buffer to enhance performance. For time-critical and high-speed tasks, the controller utilizes the SLC buffer, while TLC blocks are used for operations that do not require the high speeds of the SLC buffer but instead demand stable, sustained speeds with minimal fluctuations, such as background data storage and surveillance data recording.</p> <p>Furthermore, the SLC and TLC blocks used to store different types of data differ in storage qualities such as speed, storage density, resilience to errors, endurance, and more. SLC blocks are much faster than TLC blocks and have higher resilience to errors. TLC blocks have triple the storage density of SLC</p>

blocks. For the same price, TLC blocks provide more storage capacity compared to SLC blocks.



Appearance

Dimensions	100 mm x 69.85 mm x 6.8 mm (3.94" x 2.75" x 0.28")
Weight	53 g (1.87 oz)

Storage

Flash Type	3D NAND flash
Capacity	128 GB / 256 GB / 512 GB / 1 TB / 2 TB / 4 TB

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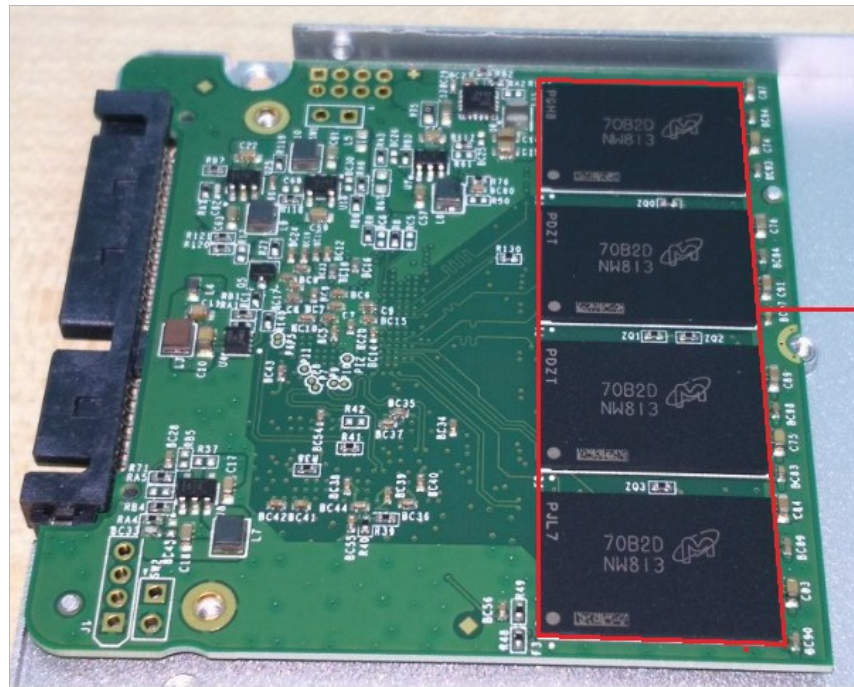


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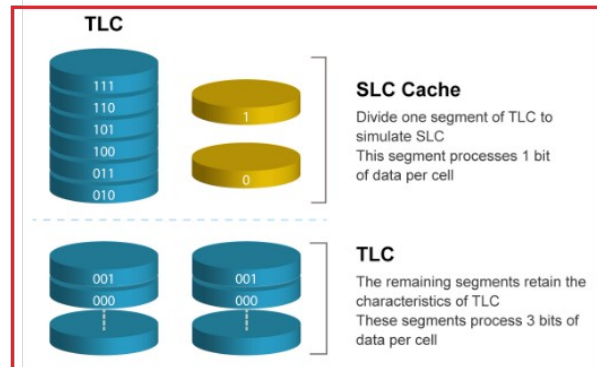
<https://thetechrevolutionist.com/2018/06/transcend-ssd230s-review-affordable-performance-oriented-ssd.html>

SLC Mode

SLC Cache limitations mean this technology cannot fulfill the demand for constant read/write at high speeds. That being so, another technology that can transform TLC into SLC has come into play—SLC Mode. Unlike SLC Cache, there are no buffer zone restraints on SLC Mode, because each TLC cell acting under this mode processes only one bit of data—just like SLC cells. Hence space constraints are removed and high read/write speeds can be sustained.



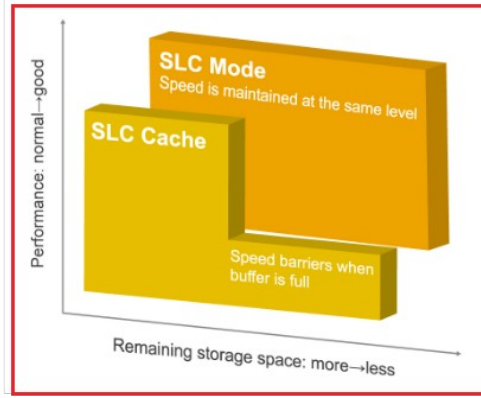
<https://www.transcend-info.com/embedded/technology/slc-mode>



SLC Cache

By dividing a segment within TLC to simulate SLC, transfer speeds within the segment will be temporarily increased. Once buffer space is full, speed will return to its original level.

<https://www.transcend-info.com/embedded/technology/slc-mode>



Although storage capacity per cell is reduced in SLC mode, taking three times amount of cells in TLC to simulate SLC, the cost is dozens of times less than SLC. This makes SLC mode an enticing alternative for companies seeking high storage capacity, high speed, and low cost.

<https://www.transcend-info.com/embedded/technology/slc-mode>

Whole-Drive Fill: Testing SLC Cache Size

Most modern drives, in order to accelerate writing speed, designate a part of the drive as an 'SLC cache'. This is part of the storage that acts in 'single bit-per-cell' mode, which allows for faster reads and writes. The reason why it isn't used across the whole drive is that it doesn't allow as much data to be stored in the same area (TLC is three bits per cell, so 3x the density). As the user puts a sustained file write on the drive, this SLC cache will fill up at full speed. If the write size is bigger than the cache and goes without a break, it can spill into normal TLC territory (which is slower). When there is a pause in operation, the drive will compact the data in the SLC cache and move it to TLC blocks, freeing up cache space for future writes. Some drives adjust the size of this SLC cache dynamically based on the amount of free space left, while others have it as a fixed capacity.

<https://www.anandtech.com/show/13759/comparing-adata-sx8200-pro-vs-hp-ex950/2>

NAND flash characteristics



<https://www.techtarget.com/searchstorage/tip/The-truth-about-SLC-vs-MLC>